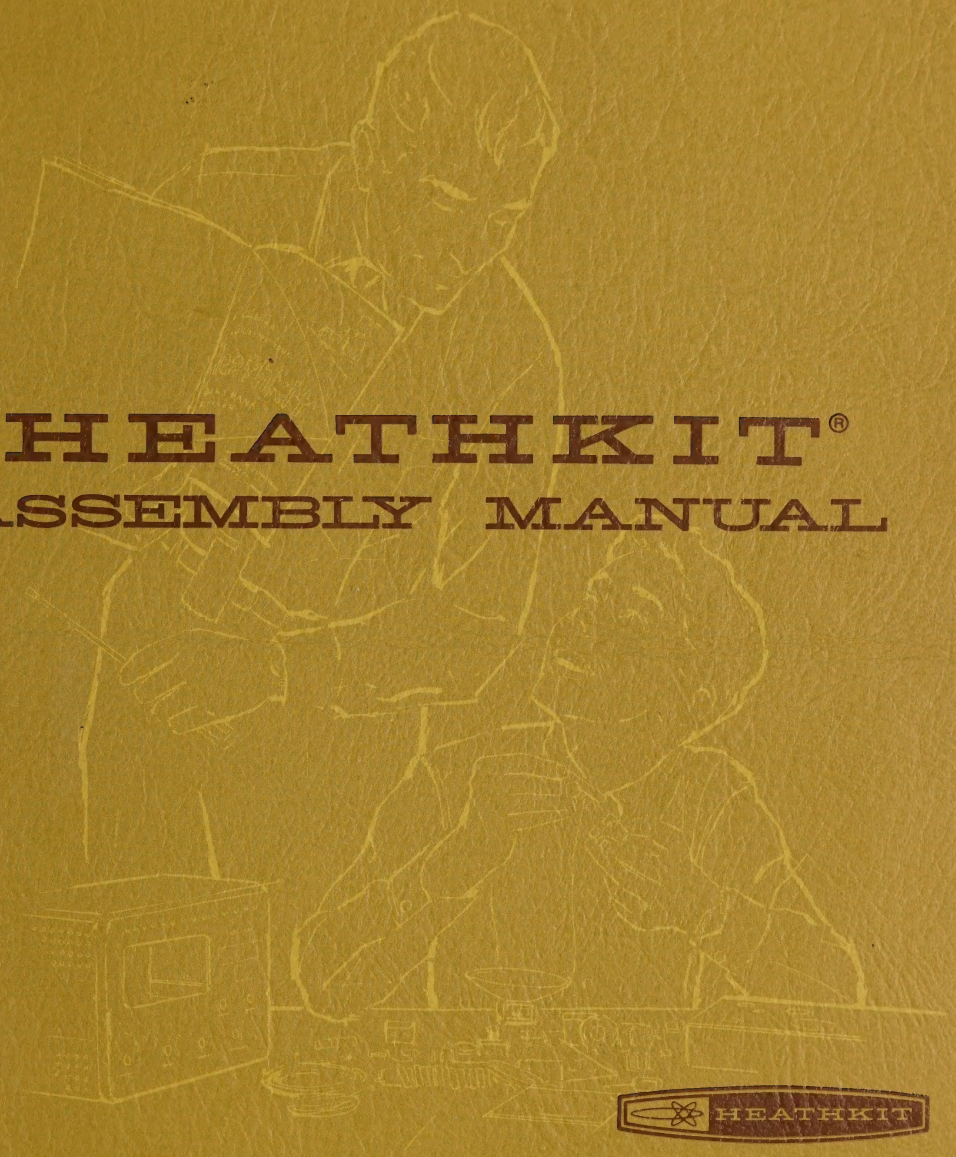
PRICE $2.00

HEATH COMPANY • BENTON HARBOR MICHIGAN

HEATHKIT®
ASSEMBLY MANUAL



HEATHKIT

AUTOMOTIVE TUNE-UP METER
MODEL ID-29

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595-1095
11-14-69

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.

Assembly
and
Operation
of the

HEATHKIT

AUTOMOTIVE TUNE-UP METER

MODEL ID-29

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HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model ID-29 Automotive Tune-Up Meter is an instrument which will aid in automotive engine troubleshooting and tune-up work. It is designed to be simple in operation and requires no set-up time. The instrument is actually three meters in one. It combines a distributor cam Dwell Meter, an electronic Tachometer, and a Direct Current Voltmeter in one package. The Dwell Meter readout is on four meter scales: one scale each for 3, 4, 6, and 8 cylinder engines. Each scale indicates the distributor point dwell in degrees. The Tachometer has two ranges with a meter scale for each range. The upper scale also provides the readout for the DC Voltmeter.

Although the Automotive Tune-Up Meter is intended mainly for use with automobile engines, it may also be used with any four-cycle engine of 3 or more cylinders, which uses a standard automotive type of ignition system.

The Solid-State circuitry is on one circuit board to simplify assembly and reduce the chance of error. No internal batteries or connections to an external power source are necessary, as all operating power is obtained from the engine under test.

The Tune-Up Meter is housed in a rugged black polypropylene case that is unaffected by water, oils, gasoline and most acids. A compartment in the front of the case provides a convenient storage space for the test cable.

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following Parts List. The numbers in parentheses correspond to the numbers on the Parts Pictorial. Parts in envelopes should be returned to the envelope after identification, until the part is called for in an assembly step.

To order replacement parts, refer to the Replacement Parts Price List and use the Parts Order Form furnished with this kit.

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
1/2 Watt		
(1) 1-3	2	100 Ω (brown-black-brown)
1-112	1	180 Ω (brown-gray-brown-gold) 5%
1-9	1	1000 Ω (brown-black-red)
1-10	1	1200 Ω (brown-red-red)
1-20	1	10 kΩ (brown-black-orange)
1-22	1	22 kΩ (red-red-orange)
1 Watt		
(2) 1-9-1	1	10 kΩ (brown-black-orange)
Precision, 1%		
(3) 2-263	1	6600 Ω (6.6 k)
2-264	1	8500 Ω (8.5 k)
2-265	1	12.2 kΩ
2-266	1	15 kΩ
2-267	1	16 kΩ
2-189	1	18 kΩ
2-268	1	24 kΩ
2-120	1	36 kΩ
2-269	1	48 kΩ

PART No.	PARTS Per Kit	DESCRIPTION
Other Resistors		
(4) 9-28	1	100 Ω thermistor
(5) 11-87	1	1000 Ω (1k) control
(6) 10-200	1	2000 Ω (2k) control
CAPACITORS		
(7) 25-199	1	500 μF electrolytic
(8) 27-34	1	.2 μF Mylar*
27-50	1	.39 μF Mylar
27-61	1	.47 μF Mylar
DIODES-TRANSISTORS		
(9) 56-26	3	1N191 crystal diode (brown-white-brown)
(10) 56-56	2	1N4149 silicon diode
56-61	2	Reference diode (stabistor)
(11) 57-27	2	1N2071 silicon diode
(12) 417-118	3	2N3393 transistor
417-201	2	29A829 transistor
SWITCHES		
(13) 63-552	1	10-terminal rotary switch
(14) 63-553	1	12-terminal rotary switch
HARDWARE		
(15) 250-89	2	6-32 x 3/8" screw
(16) 254-1	2	#6 lockwasher
(17) 252-3	2	6-32 nut
(18) 253-10	2	Switch flat washer
(19) 252-7	2	Switch nut
(20) 259-5**	2	#10 solder lug

PART No.	PARTS Per Kit	DESCRIPTION
The following hardware is included with the meter:		
(21)	4	6-32 brass nut
(22)	4	#6 bronze lockwasher
(23)	4	10-32 brass nut
(24)	2	#10 flat washer
(25)	2	#10 lockwasher
PLASTIC PARTS		
(26) 73-20	1	Red alligator clip insulator
73-21	1	Black alligator clip insulator
(27) 73-34	1	Red insulator
(28) 75-30	1	Test cable strain relief
95-29	1	Instrument case
(29) 490-5	1	Nut starter
WIRE		
89-4	1	2-conductor cable
89-20	1	Calibration cable, with plug
344-59	1	Hookup wire
MISCELLANEOUS		
(30) 46-49	1	Choke
85-311-1	1	Circuit board
(31) 203-615	1	Chassis
(32) 260-1	2	Alligator clip
407-143	1	Meter
(33) 455-50	2	Knob bushing
(34) 462-245	2	Knob
597-308	1	Kit Builders Guide
597-260	1	Parts Order Form
390-262	1	Model number label
391-34	1	Blue and white label
390-285	1	Connections label
	1	Manual (See front cover for part number.)
		Solder

*DuPont Registered Trademark

**Test accessories, see Page 17.

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1-10	1	1200 Ω (brown-red-red)
1-20	1	10 kΩ (brown-black-orange)
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2-266	1	15 kΩ
2-267	1	16 kΩ
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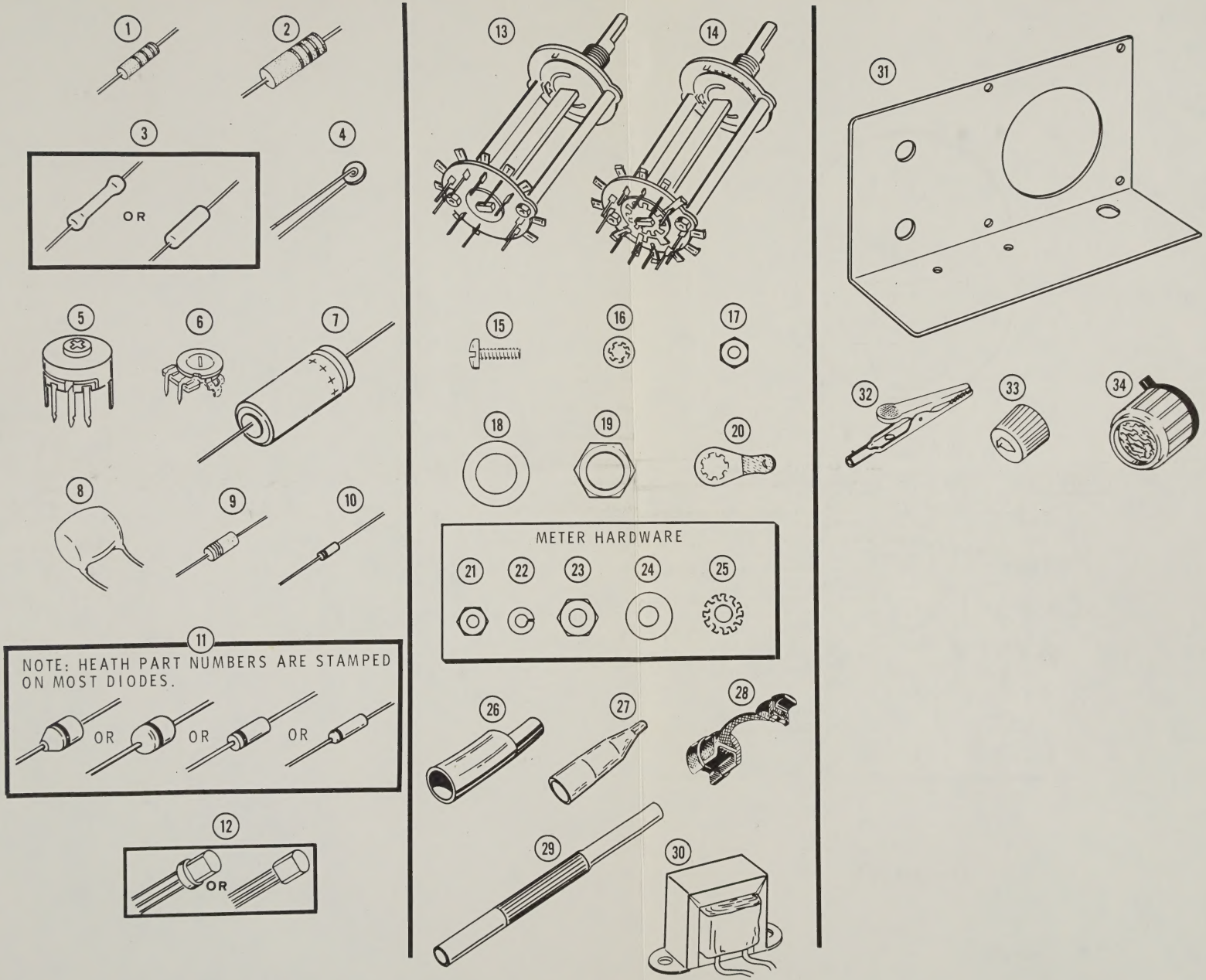
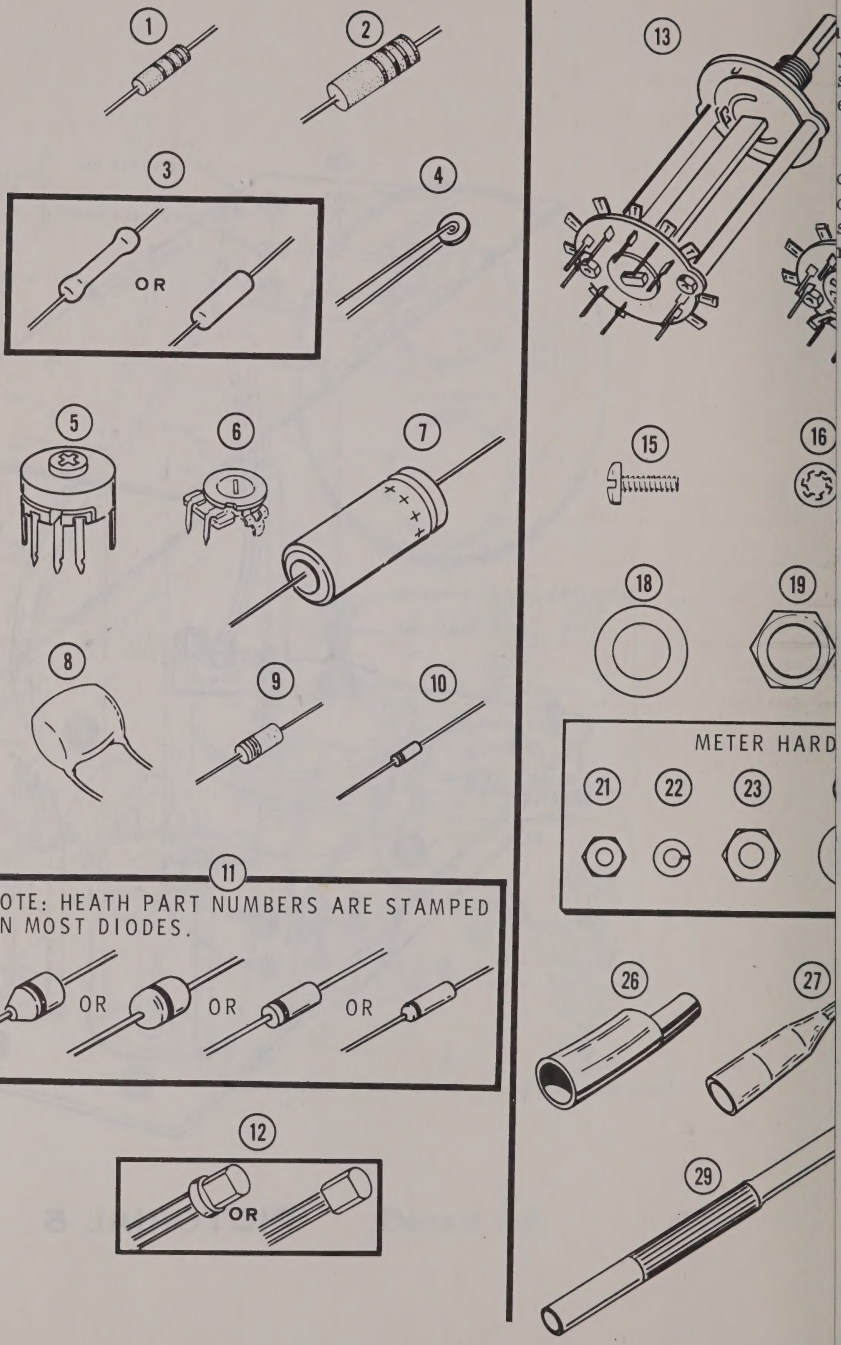
	1	Manual (See front cover for part number.)
		Solder

*DuPont Registered Trademark

**Test accessories, see Page 17.

PARTS PICTORIAL



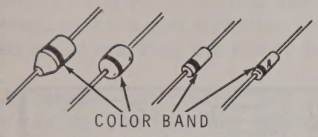

1
2
3
OR
4
5
6
7
8
9
10
11
NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES.
OR
OR
OR
12
OR
13
15
16
18
19
METER HARD
21
22
23
26
27
29

START

IDENTIFICATION DRAWING

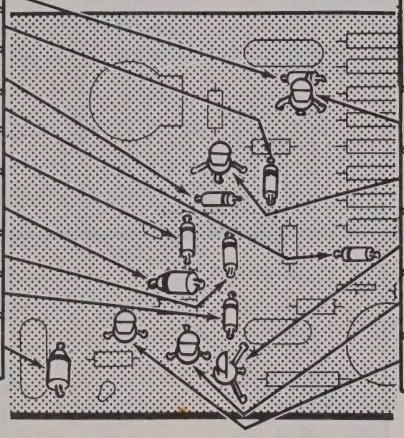
ASSEMBLY IS PERFORMED IN THIS AREA OF THE CIRCUIT BOARD.

NOTE: When installing the following diodes, be sure to position the cathode end of the diode as shown. The cathode end is marked with a band or bands.



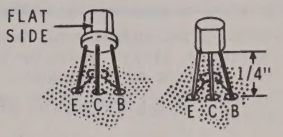
Solder each diode after it is installed and cut off the excess lead lengths.

- (✓) Diode 1N191. (#56-26) at D8.
- (✓) Diode 1N191 (#56-26) at D7.
- (✓) Diode 1N191 (#56-26) at D6.
- (✓) Diode 1N4149 (#56-56) at D9.
- (✓) Diode 1N4149 (#56-56) at D5.
- (✓) Silicon diode 1N2071 (#57-27) at D2.
- (✓) Stabistor diode (#56-61) at D4.
- (✓) Stabistor diode (#56-61) at D3.
- (✓) Silicon diode 1N2071 (#57-27) at D1.



CONTINUE

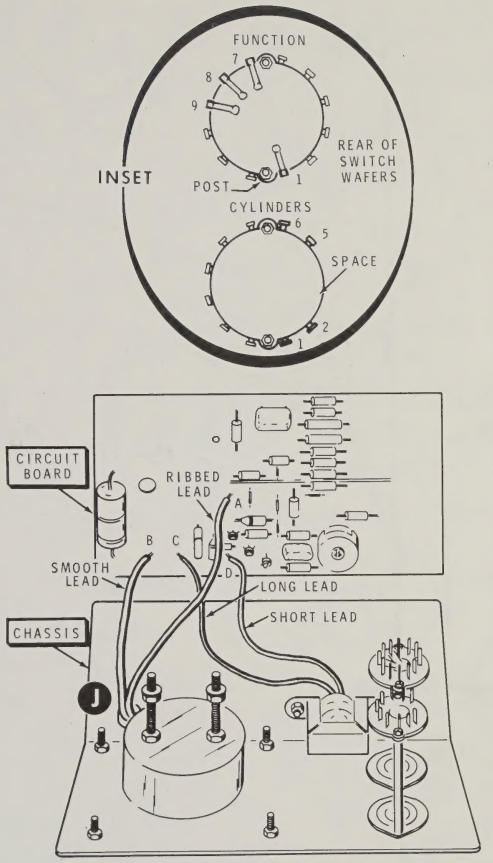
NOTE: Install the transistors in the following manner. Match the flat side of each transistor with the outline of the flat on the circuit board; then insert the emitter (E), collector (C), and base (B) leads into their proper holes. Position the transistors 1/4" away from the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



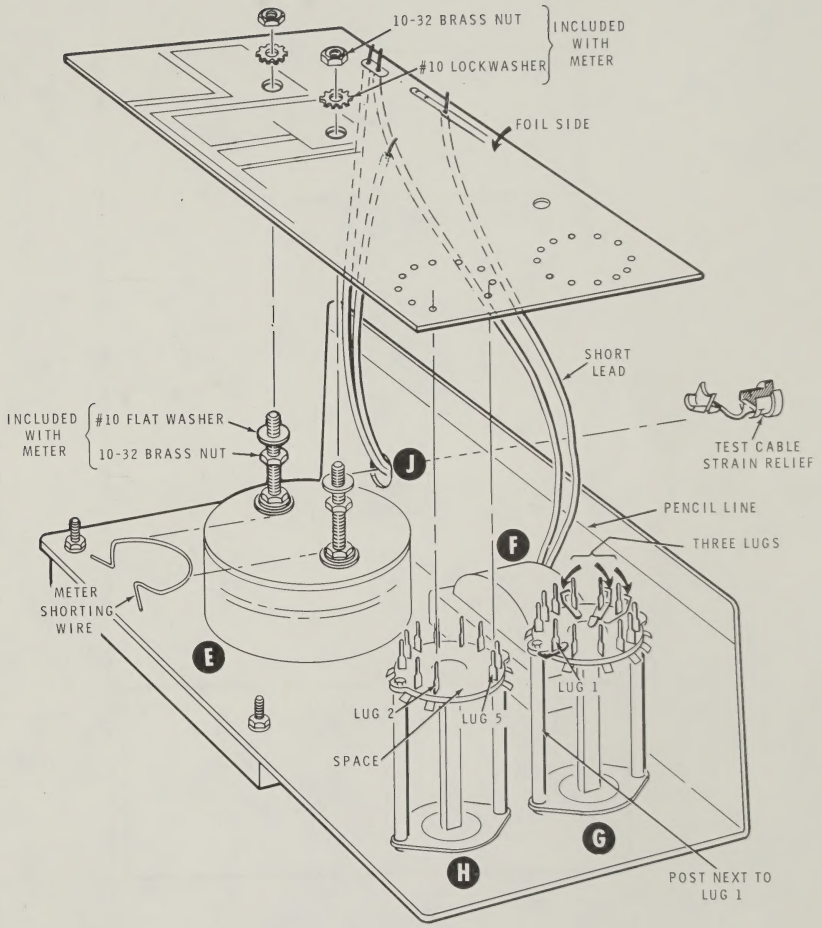
- (✓) Transistor 2N3393 (#417-118) at Q4.
- (✓) Transistor 2N3393 (#417-118) at Q5.
- (✓) Transistor 2N3393 (#417-118) at Q3.
- (✓) Transistor 29A829 (#417-201) at Q2.
- (✓) Transistor 29A829 (#417-201) at Q1.

CONTINUE WITH THE STEPS ON PICTORIAL 3.

PICTORIAL 2



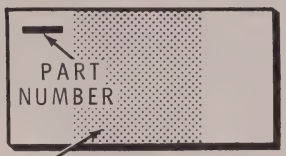
Detail 5A



PICTORIAL 5

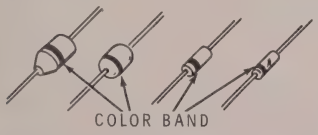
START

IDENTIFICATION DRAWING



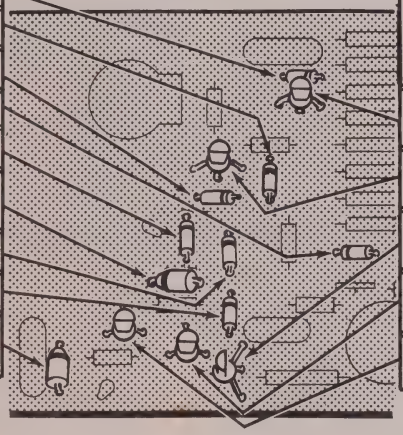
ASSEMBLY IS PERFORMED IN THIS AREA OF THE CIRCUIT BOARD.

NOTE: When installing the following diodes, be sure to position the cathode end of the diode as shown. The cathode end is marked with a band or bands.



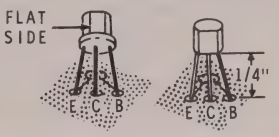
Solder each diode after it is installed and cut off the excess lead lengths.

- (✓) Diode 1N191. (#56-26) at D8.
- (✓) Diode 1N191 (#56-26) at D7.
- (✓) Diode 1N191 (#56-26) at D6.
- (✓) Diode 1N4149 (#56-56) at D9.
- (✓) Diode 1N4149 (#56-56) at D5.
- (✓) Silicon diode 1N2071 (#57-27) at D2.
- (✓) Stabistor diode (#56-61) at D4.
- (✓) Stabistor diode (#56-61) at D3.
- (✓) Silicon diode 1N2071 (#57-27) at D1.



CONTINUE

NOTE: Install the transistors in the following manner. Match the flat side of each transistor with the outline of the flat on the circuit board; then insert the emitter (E), collector (C), and base (B) leads into their proper holes. Position the transistors 1/4" away from the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



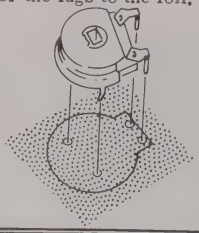
- (✓) Transistor 2N3393 (#417-118) at Q4.
- (✓) Transistor 2N3393 (#417-118) at Q5.
- (✓) Transistor 2N3393 (#417-118) at Q3.
- (✓) Transistor 29A829 (#417-201) at Q2.
- (✓) Transistor 29A829 (#417-201) at Q1.

CONTINUE WITH THE STEPS ON PICTORIAL 3.

PICTORIAL 2

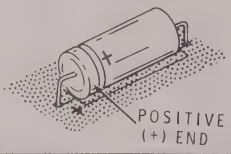
START

( ) 2000 Ω (2k) control (#10-200). Push the control firmly against the circuit board, and then solder the lugs to the foil.



( ) .47 μF Mylar.

NOTE: When mounting electrolytic capacitors, always match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.



( ) 500 μF electrolytic.

( ) .39 μF Mylar.

( ) 100 Ω (brown-black-brown).

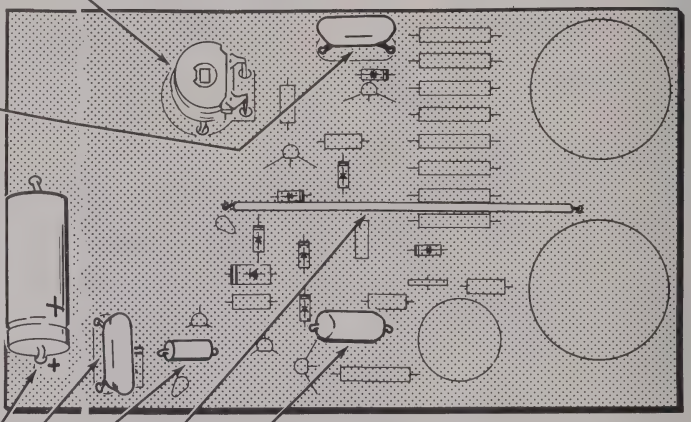
( ) Cut a 3-7/8" length of hookup wire and remove 1/4" of insulation from each end.

( ) 3-7/8" hookup wire.

( ) .2 μF Mylar.

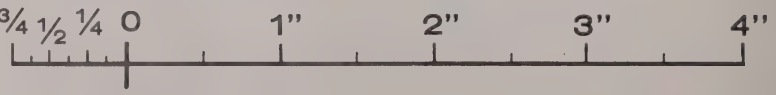
( ) Solder all leads to the foil and cut off the excess lead lengths.

This completes the circuit board assembly. Check the foil side of the circuit board to see if any connections have been missed. Make certain that there are no solder bridges between the foils. Set the circuit board aside until called for later.



PICTORIAL 3

FINISH



CHASSIS ASSEMBLY

Refer to Pictorial 4 for the following steps.

( ) Draw a light pencil line on the inside of the chassis flange 2-5/16" from the bend, as shown. This will be used later to position the circuit board.

NOTE: Before mounting the meter in the next step, place a soft covering over your work area to avoid marking the meter front.

A plastic nut starter has been provided with this kit. Use this nut starter to hold and start the 6-32 nuts on screws. Refer to Page 3 of the Kit Builders Guide for further information.

( ) Mount the meter at E with the four bronze #6 lockwashers and the four 6-32 brass nuts furnished with the meter. CAUTION: Do not overtighten the nuts. Too much tension could crack the meter case.

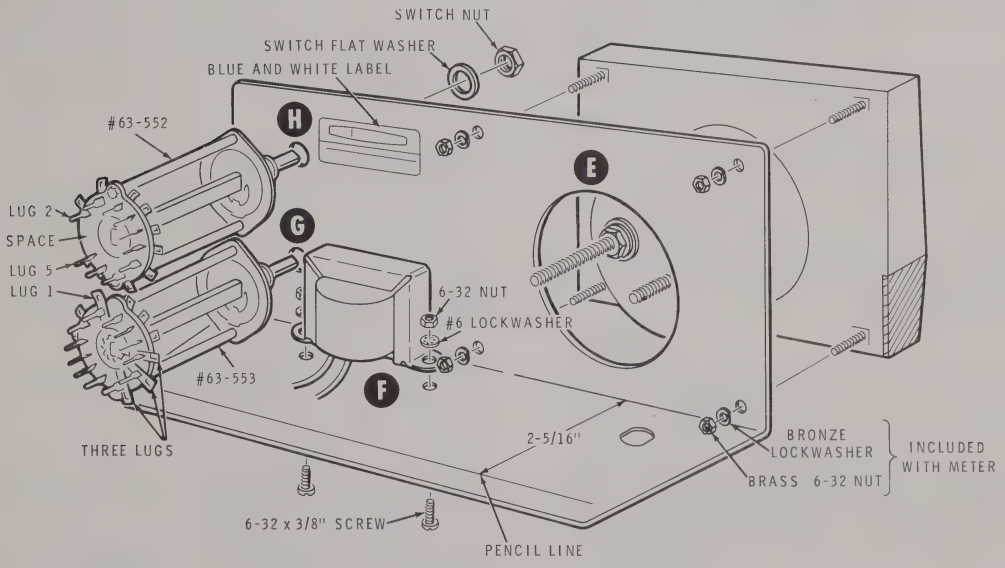
( ) Mount the choke (#46-49) on the chassis at F with two 6-32 x 3/8" screws, two #6 lockwashers, and two 6-32 nuts. Position the leads as shown.

( ) Remove the backing paper from the blue and white label and fasten the label to the back of the front panel as shown. Be sure to refer to the numbers on this label in any communications you might have with the Heath Company about this kit.

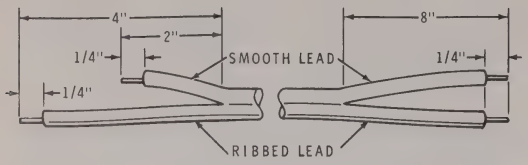
( ) Install the 12-terminal rotary switch (#63-553) at G with a switch flat washer and a switch nut as shown. Tighten the nut only finger tight.

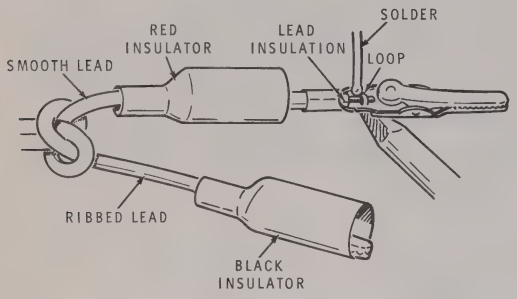
( ) Likewise, install the 10-terminal rotary switch (#63-552) at H with a switch flat washer and switch nut. Tighten the nut only finger tight.

( ) Set the chassis assembly aside until called for later.



PICTORIAL 4





Detail 4A

TEST CABLE ASSEMBLY

Refer to Detail 4A for the following steps.

NOTE: The insulation on one lead of the 2-conductor cable is smooth while the other lead is marked with ribs. This is for identification of the leads.

( ) At one end of the 2-conductor cable separate the two leads for 8", as shown in Detail 4A.

( ) Remove 1/4" of insulation from both leads. Twist the fine wires together and melt a small amount of solder on the ends of the leads to hold the fine wires together.

( ) Tie the two leads together in an Underwriter's knot.

( ) Place the red alligator clip insulator on the smooth lead and the black alligator clip insulator on the ribbed lead.

( ) Solder an alligator clip to each lead as shown.

( ) Push the insulators over the alligator clips.

( ) At the other end of this cable, separate the leads 4" and prepare the ends as shown in Detail 4A. Twist the fine wires together and melt a small amount of solder on the ends of the leads to hold the fine wires together.

CIRCUIT BOARD TO CHASSIS ASSEMBLY

( ) Position the chassis assembly and circuit board as shown in Detail 5A, fold-out from Page 4.

( ) Connect the short choke lead to circuit board hole D (S-1).

( ) Connect the long choke lead to circuit board hole C (S-1). Cut off excess lead lengths.

( ) Pass the free end (without clips) of the test cable through hole J in the chassis flange.

( ) Connect the short (smooth) lead to circuit board hole B (S-1).

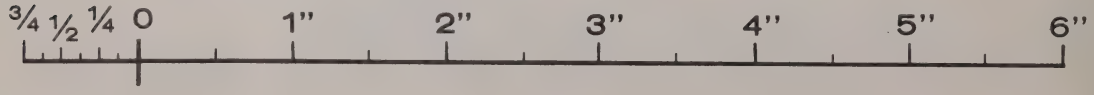
( ) Connect the long (ribbed) lead to circuit board hole A (S-1). Cut off excess lead lengths.

Refer to Pictorial 5 (fold-out from Page 4) for the following steps.

( ) Run a brass 10-32 nut (included with the meter) about halfway down each meter terminal.

( ) Place a #10 brass flat washer (included with the meter) on each meter terminal, over the nut.

( ) Make sure that switch H is still positioned so the space between lugs 2 and 5 is toward the outside edge of the chassis, as shown.



( ) Make sure that switch G is still positioned so the support post next to lug 1 is toward the top of the instrument, as shown.

NOTE: In the next step, position the two choke leads and the test cable leads close to the chassis flange and away from the meter terminal.

( ) Line up the switch lugs with the holes in the circuit board, and position the circuit board on the switches and on the meter terminals.

( ) Place a #10 lockwasher and a brass 10-32 nut on each of the meter terminals.

( ) Press the circuit board tightly against the shoulders of the switch lugs. Adjust the position of the nuts on the meter terminals so that the edge of the circuit board is parallel to the pencil line on the chassis.

( ) Position the circuit board about 1/8" above the chassis flange and tighten the meter nuts on the foil side of the circuit board as shown in Detail 5B.

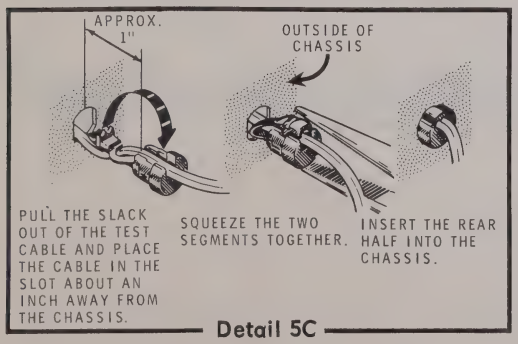
( ) Tighten the switch nuts on the front panel. CAUTION: Do not permit the switches to twist while tightening the nuts.

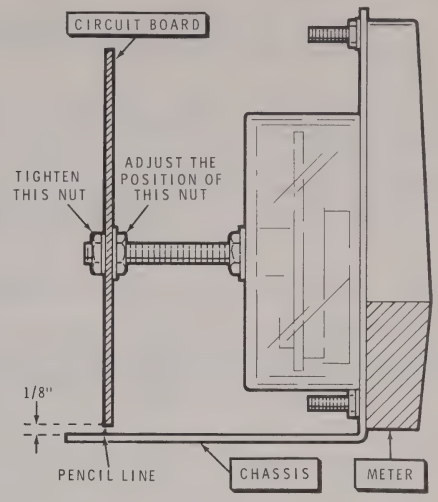
( ) Check to see that the circuit board is pressed down to the shoulders of the switch lugs.

( ) Solder all of the lugs of both switches to the circuit board foil (12 lugs on switch G, 10 lugs on switch H). It is not necessary to cut off the lugs after soldering.

( ) Check to see that all connections are soldered and that no solder bridges have formed between the foils around the switch lugs.

( ) Refer to Detail 5C and install the test cable strain relief.


APPROX. 1"
OUTSIDE OF CHASSIS
PULL THE SLACK OUT OF THE TEST CABLE AND PLACE THE CABLE IN THE SLOT ABOUT AN INCH AWAY FROM THE CHASSIS.
SQUEEZE THE TWO SEGMENTS TOGETHER.
INSERT THE REAR HALF INTO THE CHASSIS.
Detail 5C



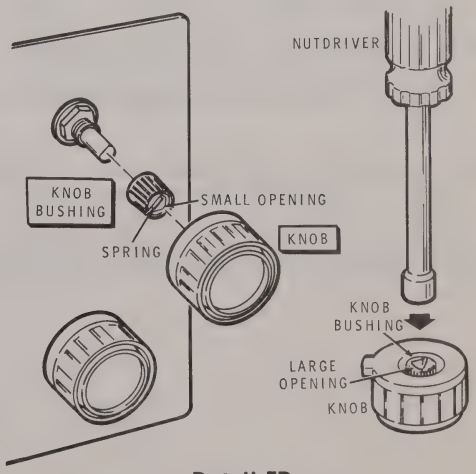
Detail 5B

Refer to Detail 5D for the following steps.

( ) Press a knob bushing as far as it will go onto the shaft of the FUNCTION switch. Make sure that the spring tab is facing outward.

( ) Turn the switch shaft fully counterclockwise.

( ) Press a knob partly onto the knob bushing with the pointer in line with the word "DWELL".



Detail 5D

(✓) Remove the knob-bushing assembly and press the bushing into the knob as far as it will go.

(✓) Replace the knob-bushing assembly on the switch shaft.

( ) Press a knob bushing as far as it will go onto the shaft of the Cylinders switch. Be sure the spring tab is facing outward.

( ) Turn the switch shaft fully counterclockwise.

( ) Push a knob partly onto the knob bushing with the pointer in line with the number "8".

( ) Remove the knob-bushing assembly and press the bushing into the knob as far as it will go.

( ) Replace the knob-bushing assembly on the switch shaft.

( ) Remove and discard the shorting wire from between the meter terminals.

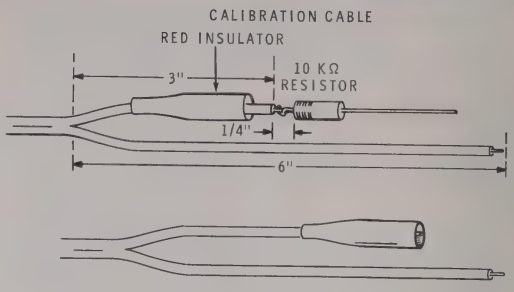
This completes the circuit board and chassis assembly. Check the circuit board connections to see that they are soldered. Check also to see that there are no solder bridges between adjacent foils, especially around the switch lugs and foils.

CALIBRATION CABLE ASSEMBLY

Refer to Pictorial 6 for the following steps.

( ) Separate the leads of the calibration cable for 6".

NOTE: Solder the leads of the calibration cable as quickly as possible. These leads consist of plastic strands with foil ribbons wrapped around them. Overheating will melt the plastic strands, leaving only the foil which will break easily.



PICTORIAL 6

( ) Cut one lead of the calibration cable to 3". Prepare the end by removing 1/4" of insulation and melting a small amount of solder on the end of the lead to hold the foils together.

( ) Push the red insulator onto the short lead of the calibration cable.

( ) Cut one lead of the 10 kΩ (brown-black-orange) 1 watt resistor to 1/4".

( ) Bend a small loop in the 1/4" lead of the resistor.

( ) Solder the short lead of the calibration cable to the loop in the resistor lead.

( ) Push the red insulator over the body of the resistor, making sure the insulator covers the solder connection.

( ) Cut off the long resistor lead so that it is even with the large open end of the insulator. There should be approximately 3/16" of resistor lead remaining.

This completes the assembly of the calibration cable. Proceed with the Operation-Test-Calibration section.

OPERATION-TEST-CALIBRATION

OPERATION

Refer to Figure 1 (fold-out from Page 13) for the operation of the switches, calibration controls, and for instructions on reading the Meter scales.

Refer to the In Case of Difficulty section if the following test or calibrations do not perform as described.

TEST

( ) Set the FUNCTION switch at DC VOLTS.

( ) The CYLINDERS switch may be in any position.

( ) Connect the black test clip to the negative (-) post of a battery of not over 15 volts.

( ) Touch the red clip to the positive (+) battery post. The meter should indicate the voltage of the battery. If the meter tries to read down scale, the red and black clip insulators are on the wrong leads and will have to be changed.

( ) Disconnect the test clips from the battery.

CALIBRATION

Zero Set

( ) Fasten the two test lead clips together.

( ) Position the Instrument so that the meter is facing upward.

( ) If necessary, adjust the Zero Set until the meter pointer reads exactly zero. (See Figure 1, fold-out from Page 13).

NOTE: Once set, the zero adjustment should remain indefinitely, and it will not be necessary to readjust each time the instrument is used. It is good practice, however, to check the zero reading occasionally to make sure that no change has occurred.

Dwell Calibration

NOTE: If possible, this calibration should be performed using a voltage near 6 volts DC. After calibration, the instrument should be checked at a higher voltage, such as 12 volts DC.

The meter indication should be approximately the same for both voltages. This is to check to see that the regulator circuit is functioning properly.

Refer to Figure 2 for the following steps.

( ) Set the FUNCTION switch at DWELL. The CYLINDERS switch can be in any position.

( ) Set the DWELL CAL control at the center of its range.

( ) Observing correct polarity, connect the black test lead to the negative (-) terminal and the red test lead to the positive (+) terminal of any DC voltage source between 5 and 15 volts, such as an automobile battery.

( ) Adjust the DWELL CAL control until the meter reads exactly full scale.

( ) Disconnect the test leads from the voltage source.

Tachometer Calibration

WARNING: Use caution in handling the Tune-Up Meter when the calibration cable is plugged into a 120 VAC outlet. Some circuit board foils will have line voltage in them, therefore, a shock hazard exists.

Refer to Figure 3 for the following steps.

( ) Set the FUNCTION switch at LOW RPM.

( ) Set the CYLINDERS switch at 6.

( ) Set the TAC CAL control at its midrange.

( ) Connect the test leads to the calibration cable, red to the resistor, black to the plain lead.

NOTE: The calibration cable should not remain plugged in longer than necessary to accomplish the calibration of the instrument (about 2-3 minutes). The resistor will overheat if left on for too long a time.

( ) Plug the calibrating cable into a 120 VAC 60 Hz outlet. (Standard household outlet.)

( ) Using a screwdriver with an insulated handle, adjust the TAC CAL control until the meter reads 1200 RPM (12 on the 0-15 scale).

( ) Unplug the calibrating cable and disconnect the test leads.

This concludes the Operation-Test-Calibration of the Tune-Up Meter. Proceed with the Final Assembly.

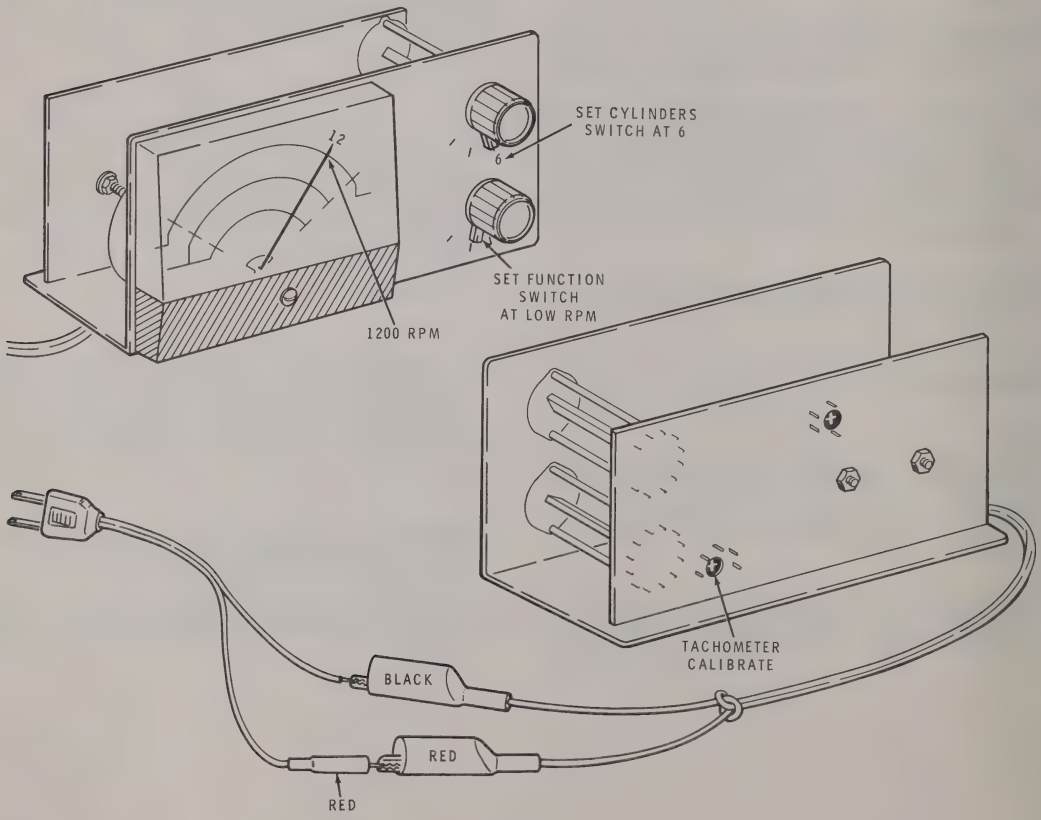


Figure 3

FINAL ASSEMBLY

Refer to Pictorial 7 for the following steps.

NOTE: When the Tune-Up Meter has been calibrated, it should remain in calibration indefinitely, however, save the calibrating cable in case it might be needed again. If desired, it can be taped or tied to the inside of the instrument for convenient storage.

( ) Fit the edges of the chassis flange into the meter case side grooves.

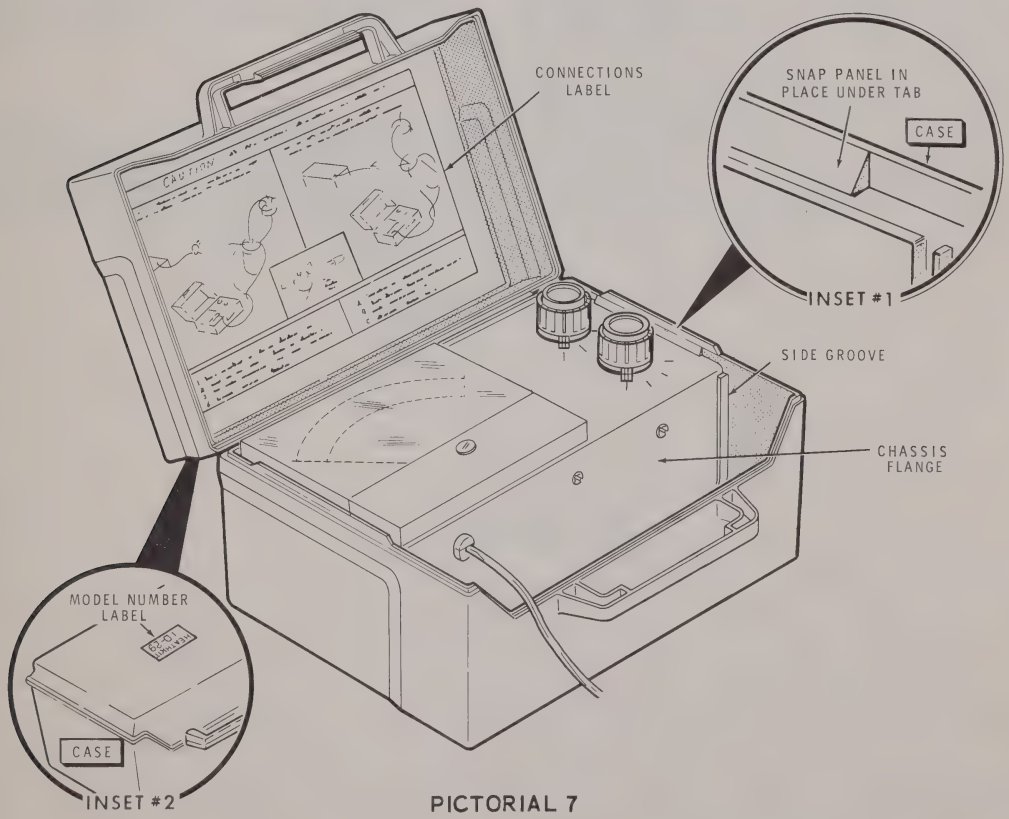
( ) Slide the chassis into the case until the ends of the chassis front snap under the tabs at the sides of the case as shown in inset #1. A little pressure on the front will snap them in place.

( ) Remove the backing paper from the large connections label and fasten the label to the inside of the cover.

( ) Coil the test lead and store it in the space in front of the chassis flange.

( ) Remove the backing paper from the model number label and fasten the label in the small recess in the outside of the case cover, as shown in inset #2 of Pictorial 7.

This completes the assembly of your Heathkit Model ID-29 Automotive Tune-Up Meter.



PICTORIAL 7

Tachometer Calibration

WARNING: Use caution in handling the Tune-Up Meter when the calibration cable is plugged into a 120 VAC outlet. Some circuit board foils will have line voltage in them, therefore, a shock hazard exists.

Refer to Figure 3 for the following steps.

( ) Set the FUNCTION switch at LOW RPM.

( ) Set the CYLINDERS switch at 6.

( ) Set the TAC CAL control at its midrange.

( ) Connect the test leads to the calibration cable, red to the resistor, black to the plain lead.

NOTE: The calibration cable should not remain plugged in longer than necessary to accomplish the calibration of the instrument (about 2-3 minutes). The resistor will overheat if left on for too long a time.

( ) Plug the calibrating cable into a 120 VAC 60 Hz outlet. (Standard household outlet.)

( ) Using a screwdriver with an insulated handle, adjust the TAC CAL control until the meter reads 1200 RPM (12 on the 0-15 scale).

( ) Unplug the calibrating cable and disconnect the test leads.

This concludes the Operation-Test-Calibration of the Tune-Up Meter. Proceed with the Final Assembly.

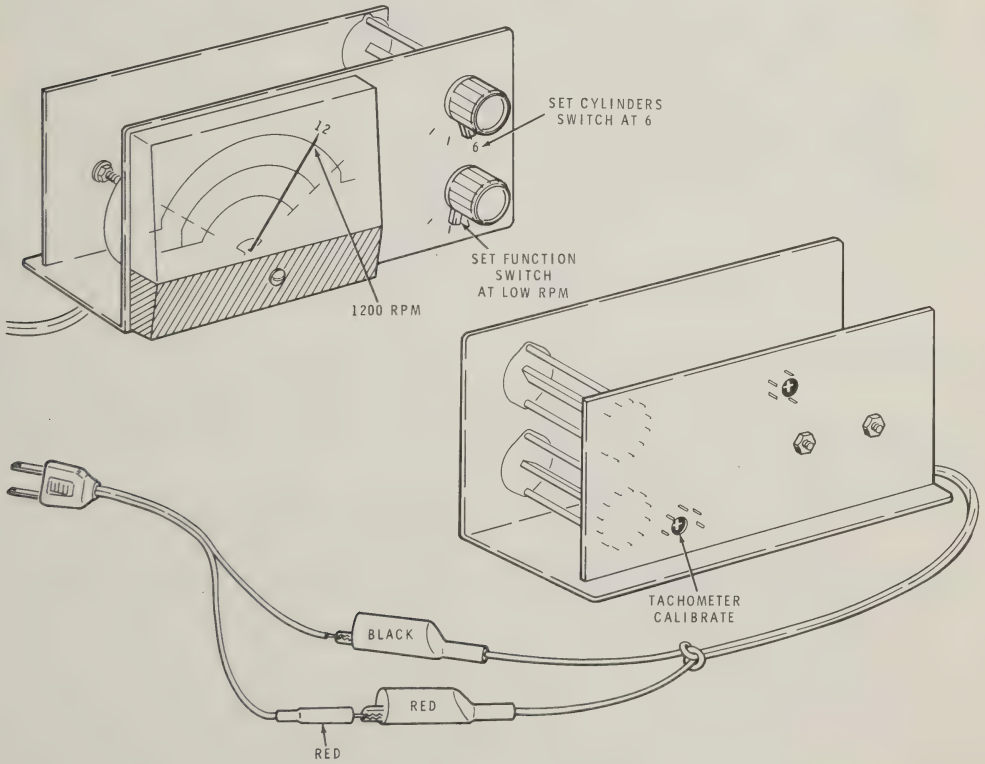


Figure 3

FINAL ASSEMBLY

Refer to Pictorial 7 for the following steps.

NOTE: When the Tune-Up Meter has been calibrated, it should remain in calibration indefinitely, however, save the calibrating cable in case it might be needed again. If desired, it can be taped or tied to the inside of the instrument for convenient storage.

( ) Fit the edges of the chassis flange into the meter case side grooves.

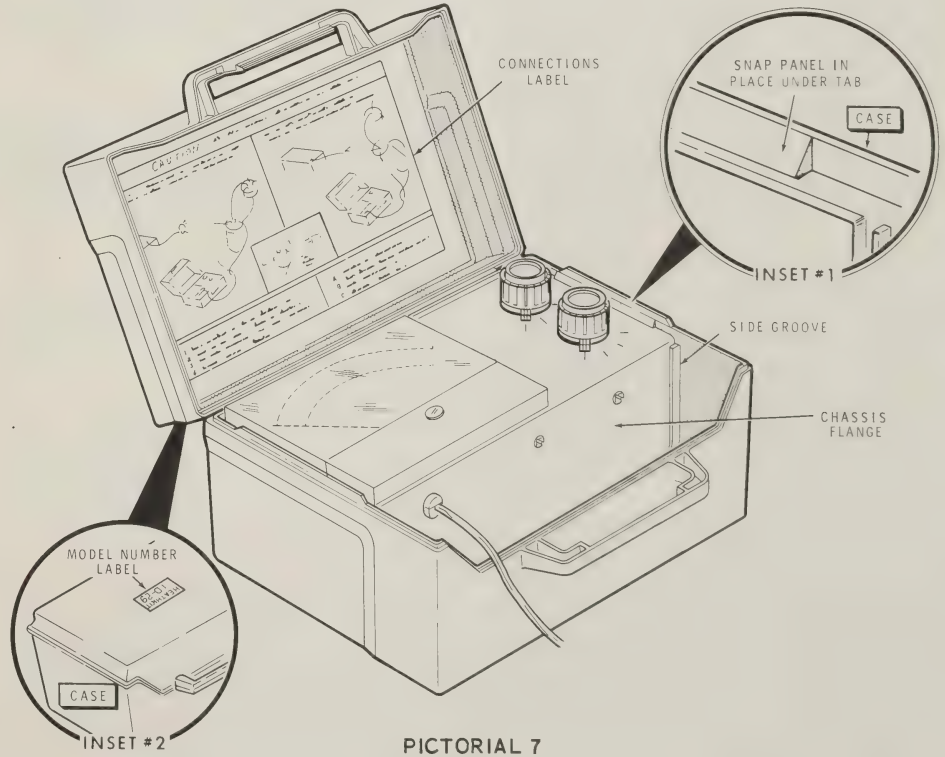
( ) Slide the chassis into the case until the ends of the chassis front snap under the tabs at the sides of the case as shown in inset #1. A little pressure on the front will snap them in place.

( ) Remove the backing paper from the large connections label and fasten the label to the inside of the cover.

( ) Coil the test lead and store it in the space in front of the chassis flange.

( ) Remove the backing paper from the model number label and fasten the label in the small recess in the outside of the case cover, as shown in inset #2 of Pictorial 7.

This completes the assembly of your Heathkit Model ID-29 Automotive Tune-Up Meter.



PICTORIAL 7

METER SCALES

VOLTS

The 0-15 scale indicates DC volts when FUNCTION switch is turned to DC VOLTS, 15 volt range.

RPM x 100

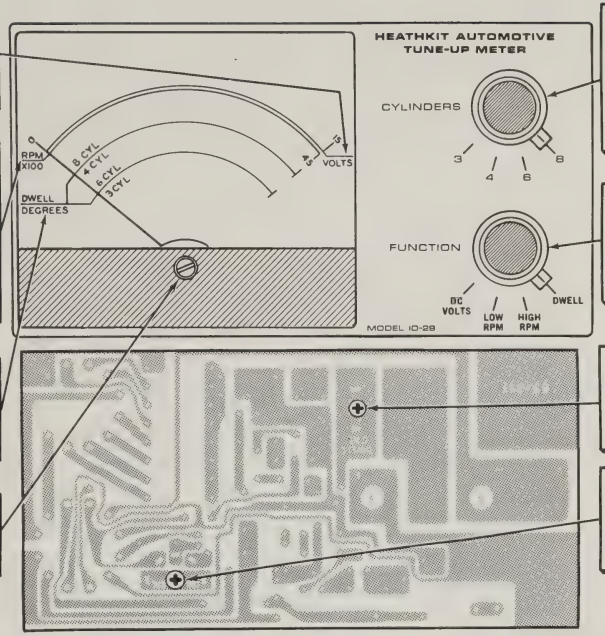
The 0 to 15 scale indicates the RPM when the FUNCTION switch is in the LOW RPM position. The 0 to 45 scale indicates the RPM when the FUNCTION switch is in the HIGH RPM position. Multiply both scale readings by 100 for actual RPM.

DWELL DEGREES

These scales indicate distributor cam angle in degrees. Four scales, for 3, 4, 6, and 8 cylinder engines.

ZERO SET

Use this, when necessary, to adjust the pointer to zero.



CYLINDERS

This switch selects the correct circuitry corresponding to the number of cylinders in the engine under test. Operates only when FUNCTION switch is in one of the tachometer (RPM) positions.

FUNCTION

This switch selects the desired function of the instrument, DWELL, two RPM ranges, and DC VOLTS.

DWELL CAL

Dwell meter calibrating control. This control calibrates meter to indicate dwell angles correctly.

TAC CAL

Tachometer calibrating control. This control calibrates meter to indicate the correct RPM.

FIGURE 1

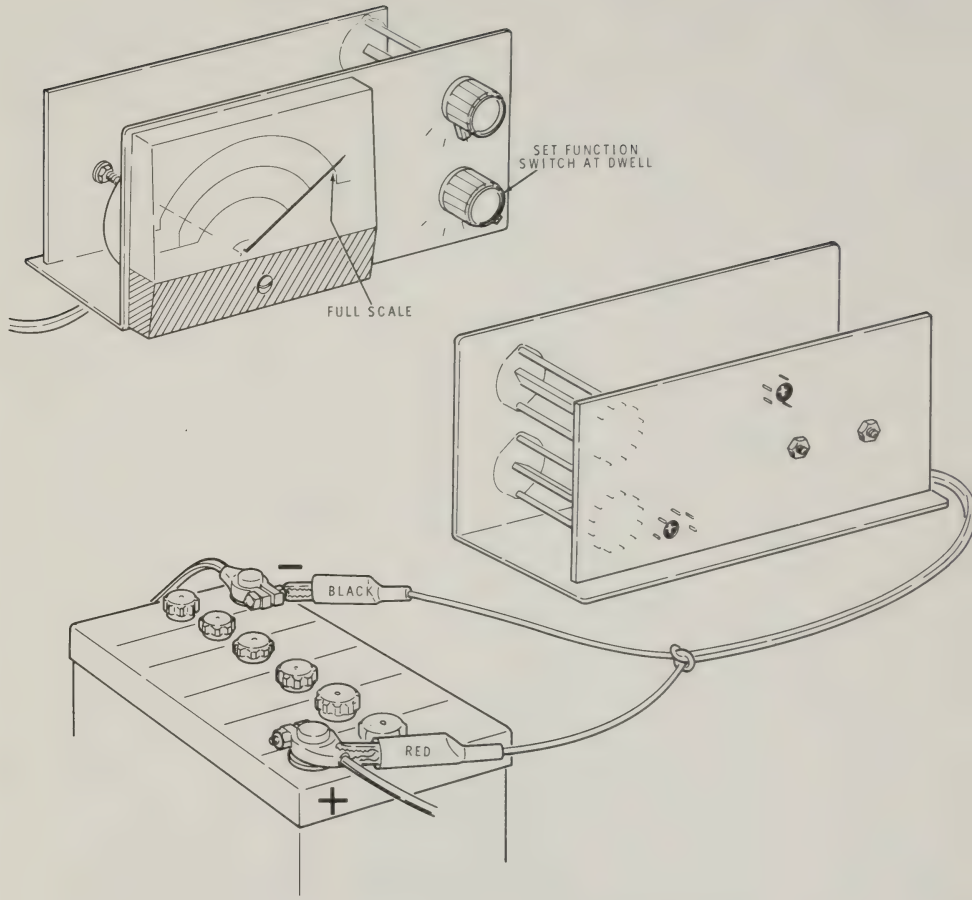


FIGURE 2

METER SCALES

VOLTS

The 0-15 scale indicates DC volts when FUNCTION switch is turned to DC VOLTS, 15 volt range.

RPM x 100

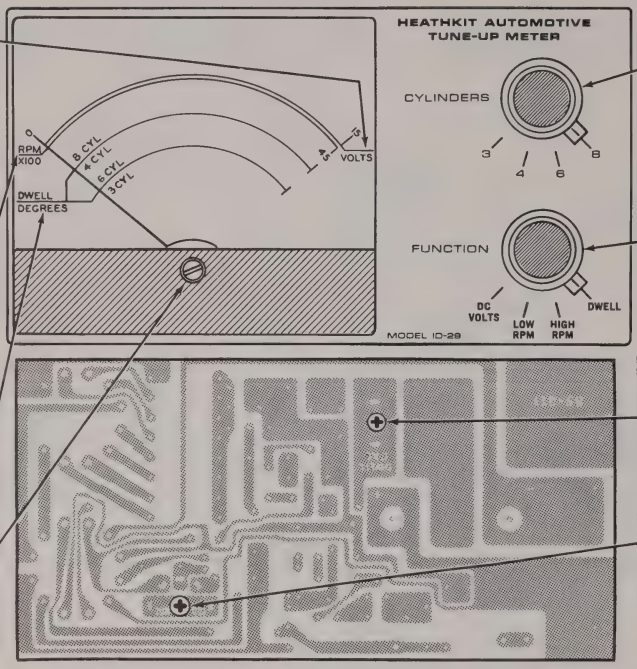
The 0 to 15 scale indicates the RPM when the FUNCTION switch is in the LOW RPM position. The 0 to 45 scale indicates the RPM when the FUNCTION switch is in the HIGH RPM position. Multiply both scale readings by 100 for actual RPM.

DWELL DEGREES

These scales indicate distributor cam angle in degrees. Four scales, for 3, 4, 6, and 8 cylinder engines.

ZERO SET

Use this, when necessary, to adjust the pointer to zero.



CYLINDERS

This switch selects the correct circuitry corresponding to the number of cylinders in the engine under test. Operates only when FUNCTION switch is in one of the tachometer (RPM) positions.

FUNCTION

This switch selects the desired function of the instrument, DWELL, two RPM ranges, and DC VOLTS.

DWELL CAL

Dwell meter calibrating control. This control calibrates meter to indicate dwell angles correctly.

TAC CAL

Tachometer calibrating control. This control calibrates meter to indicate the correct RPM.

FIGURE 1

Troubleshooting Chart

DIFFICULTY	POSSIBLE CAUSE
Instrument is inoperative in all modes.	1. Meter shorting wire not removed. 2. Poor connection to engine under test. 3. Choke L1 open. 4. Capactor C1 shorted. 5. Meter open.
Only Voltmeter inoperative; or Voltmeter reads incorrectly.	1. Resistor R18. 2. Transistor Q2. (If meter reads no higher than approximately 5 volts.)
Only Dwell Meter inoperative.	1. Diode D5, D6, or D7. 2. Resistor R3. 3. Resistor R4.
Only Tachometer inoperative.	1. Transistor Q3, Q4, or Q5. 2. Selected timing resistor (R5 through R9, R11 through R13). 3. Capacitor C3. 4. Resistors R14, R15, R16 or R17. 5. Diode D8 or D9.
Dwell Meter and Tachometer inoperative.	1. Transistor Q1 or Q2. 2. Diode D1, D2, D3 or D4. 3. Capacitor C2. 4. Capacitor C4.
Dwell Meter reads incorrectly. Tachometer O.K.	1. Recheck calibration. 2. Capacitor C2. 3. Resistor R3 changed in value. 4. Diode D5, D6, or D7. 5. Transistor Q2.
Tachometer reads incorrectly. Dwell Meter O.K.	1. Recheck calibration. 2. Capacitor C3. 3. Diode D8. 4. Selected timing resistor (R5 through R9, R11 through R13) incorrect or changed in value. 5. Resistors R19 or R21.
Tachometer and Dwell Meter both read incorrectly or erratic.	1. Leads to engine under test reversed. 2. Diode D2, D3, or D4. 3. Transistor Q1 or Q2. 4. Resistor R1 or R2.

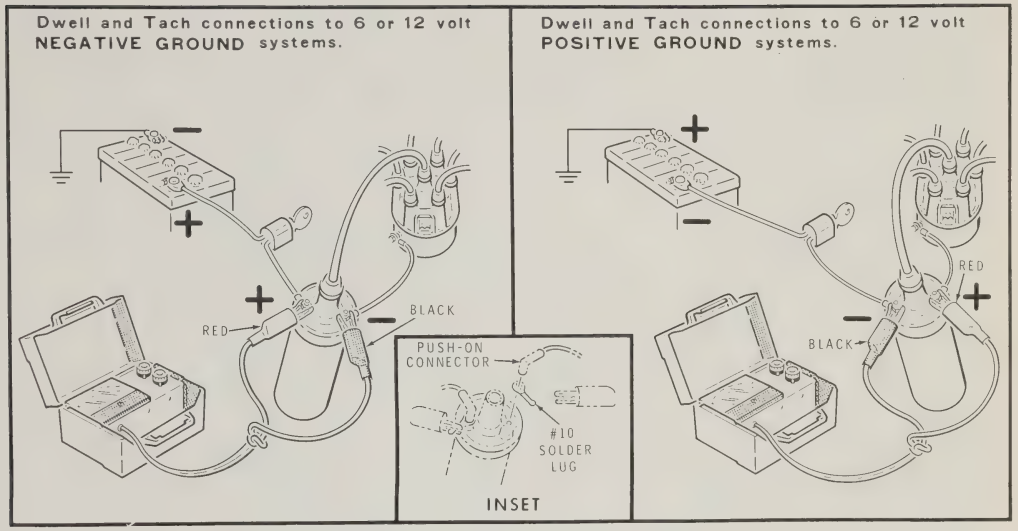


FIGURE 4

IN CASE OF DIFFICULTY

Begin your search for any troubles that occur after assembly by carefully following the checks listed below. After visual tests are completed, refer to the Troubleshooting Chart.

1. About 90% of the kits that are returned for repair do not function properly because of poor connections or soldering. Therefore, many troubles can be eliminated by re-soldering all connections to make sure they are soldered as described in the Soldering section of the Kit Builders Guide.

2. Check to see that all transistors are in their proper locations. Make sure each transistor lead is connected to the proper point.

3. Check the polarity of the diodes. Make certain that the cathode (banded) end is located as it is shown on the circuit board.

4. Make certain that the right part is in the right place. Some components resemble others very closely and can be distinguished only by part numbers, type numbers, or color code. Recheck the numbers of the components in question with the identifying numbers in the Parts List on Pages 2 and 3.

5. Check for solder bridges or short circuits between adjacent foils on the circuit board, especially around the FUNCTION switch where the foils are very close together.

6. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something that you have repeatedly overlooked.

The following Troubleshooting Chart will help you to locate the cause of difficulties that might be encountered. Refer to the Circuit Board X-Ray View on Page 24 for the location of parts as numbered in the Schematic. Reading the circuit description may prove helpful in locating the area of the circuit that may be causing a problem.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the Service and Warranty sections of the "Kit Builders Guide", and to the "Factory Repair Service" information on Page 28 of this Manual.

Troubleshooting Chart

DIFFICULTY	POSSIBLE CAUSE
Instrument is inoperative in all modes.	1. Meter shorting wire not removed. 2. Poor connection to engine under test. 3. Choke L1 open. 4. Capactor C1 shorted. 5. Meter open.
Only Voltmeter inoperative; or Voltmeter reads incorrectly.	1. Resistor R18. 2. Transistor Q2. (If meter reads no higher than approximately 5 volts.)
Only Dwell Meter inoperative.	1. Diode D5, D6, or D7. 2. Resistor R3. 3. Resistor R4.
Only Tachometer inoperative.	1. Transistor Q3, Q4, or Q5. 2. Selected timing resistor (R5 through R9, R11 through R13). 3. Capacitor C3. 4. Resistors R14, R15, R16 or R17. 5. Diode D8 or D9.
Dwell Meter and Tachometer inoperative.	1. Transistor Q1 or Q2. 2. Diode D1, D2, D3 or D4. 3. Capacitor C2. 4. Capacitor C4.
Dwell Meter reads incorrectly. Tachometer O.K.	1. Recheck calibration. 2. Capacitor C2. 3. Resistor R3 changed in value. 4. Diode D5, D6, or D7. 5. Transistor Q2.
Tachometer reads incorrectly. Dwell Meter O.K.	1. Recheck calibration. 2. Capacitor C3. 3. Diode D8. 4. Selected timing resistor (R5 through R9, R11 through R13) incorrect or changed in value. 5. Resistors R19 or R21.
Tachometer and Dwell Meter both read incorrectly or erratic.	1. Leads to engine under test reversed. 2. Diode D2, D3, or D4. 3. Transistor Q1 or Q2. 4. Resistor R1 or R2.

SPECIFICATIONS

Dwell Meter.	Four direct reading scales: 8 CYL -- 0-45 degrees. 6 CYL -- 0-60 degrees. 4 CYL -- 0-90 degrees. 3 CYL -- 0-120 degrees.
Tachometer.	Two Ranges: Low RPM: 0-1500 High RPM: 0-4500
Voltmeter.	Direct reading scale, 0-15 volts DC.
Power Requirements.	Approximate average current 10 mA.
Meter.	4-1/2", 1 mA, 100 degree movement.
Accuracy.	±3% of full scale.
Dimensions.	8-1/2" wide x 4-1/4" high x 7-1/4" deep (including handle).
Net Weight.	2-1/2 lbs.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligations to incorporate new features in instruments previously sold.

APPLICATIONS

The Automotive Tune-Up Meter is designed to be used with engines that have standard automotive battery-distributor ignition systems. It may be used with either 6 or 12 volt systems, with either negative or positive ground. Always connect the black test lead to the negative (-) terminal, of the coil regardless of ground polarity. The following instructions apply only to engines with standard automotive ignition systems.

CAUTION: This instrument is not recommended for use on cars having Solid-State ignition systems. Cars having accessory Solid-State ignition systems should be changed back to the original ignition system until you have finished using the Automotive Tune-Up Meter, and then change back to the Solid-State system.

Refer to Figure 4 (fold-out from Page 14) for Dwell Meter and Tachometer connections.

DWELL

Dwell refers to the length of time that the distributor contact points remain closed prior to their opening to generate the next ignition spark. This duration is usually measured in degrees of rotation of the distributor cam, rather than fractions of seconds. Therefore, a dwell measurement will be independent of engine speed, under normal circumstances. Use the normal idling speed, as recommended by the engine manufacturer, when making dwell measurements.

Dwell Measurement

WARNING Whenever making tests on an automobile with the engine running, make absolutely certain of adequate ventilation. Exhaust gasses are deadly.

1. Start the engine and allow it to come to normal operating temperature.

2. Set the FUNCTION switch to Dwell. Disregard the CYLINDERS switch for dwell measurements.

3. Connect the test leads to the primary of the ignition coil, as shown in Figure 4. Be sure the polarity is correct.

WARNING: Keep all wires away from the fan blades.

NOTE: Some ignition coil wires have insulators that completely cover the ignition coil terminals. Use the two #10 solder lugs provided as shown in the inset drawing of Figure 4. Remember to remove the solder lugs when you have finished making adjustments with the Tune-Up Meter.

4. Read the degrees of dwell directly from the meter. Use the scale appropriate to the number of cylinders of the engine under test.

NOTE: Dwell readings made at engine speeds above 2500 RPM are not necessarily valid.

Dwell Adjustment

Check the engine manufacturer's specifications for dwell angle. If the meter reading is less than the specified figure, the distributor point gap is too wide and must be decreased. On the other hand, if the meter reading is too high, the gap is too narrow and must be increased. Some distributors have access windows so the distributor point gap can be adjusted while the engine is running. Adjust the points according to the manufacturer's instructions while watching the Dwell Meter.

For distributors without access windows, stop the engine and remove the distributor cap. Rotate the engine until the rubbing block of the movable point rests on a high point of the distributor cam. Adjust the point gap in the direction indicated by the Dwell Meter. Reassemble the distributor, start the engine, and read the new dwell angle on the meter. Repeat this procedure until the indicated dwell angle is within the manufacturer's specifications.

An alternative method for setting the dwell angle may be used if the spark plugs are removed from the engine. With the spark plugs out, the starter motor will crank the engine fast enough and smoothly enough to permit significant dwell readings to be made.

Remove the coil cable from the distributor cap and position the free end of this cable against the engine block or other suitable ground. When the engine is cranked by the starter motor, the coil must discharge to ground. Otherwise, the coil could be damaged. Remove the distributor cap and rotor. Connect the Tune-Up Meter to the coil, as shown in Figure 4. Turn on the ignition and set the distributor points for the proper dwell angle while the starter motor cranks the engine. After the ignition system is back together and operating, recheck the dwell under actual running conditions.

The Importance of Proper Dwell Angle

The spark for ignition is generated when the distributor points, which are in the ignition coil primary circuit, are opened and the magnetic field in the coil collapses.

This collapse is very rapid and causes an induced voltage of high potential in the secondary of the coil. To prepare for the next spark, the distributor points must close again and let the magnetic field build up again in the coil. Although electrical changes are extremely rapid, the buildup of the magnetic field is not instantaneous. If the distributor points do not remain closed long enough, the magnetic field will not have time to build up to its maximum level. The result will be low secondary voltage, or in other words, a weak spark. This phenomenon is particularly noticeable at high speeds, and it can cause misfiring. It can also cause difficulty in starting an engine, particularly in cold weather. In order to reduce this problem as much as possible, it is necessary to allow the distributor points to remain closed as long as possible. Automobile manufacturers recommend what they have found to be the best dwell setting for their engines. If you use their recommendations, you should be getting the best performance from your car's ignition system.

As the dwell angle is independent of engine speed, the reading on the dwell meter should remain fairly constant at all engine speeds. A change in dwell angle reading, or a wavering of the meter pointer can mean one or a combination of several faults. A fluttering pointer at high speeds can indicate that the points are "bouncing." This means when the points close, they bounce open slightly before the distributor cam opens them. More tension on the movable point spring can correct this fault. If the meter pointer wavers, the distributor cam shaft could be wobbling, due to worn bearings; or the cam could be worn.

NOTE: Some engine manufacturers intentionally change the dwell angle at approximately 1000 RPM. If the engine under test changes dwell angle, check the tune-up specifications to see if it is intentional.

TACHOMETER

The Tachometer measures the rotational speed of an engine and is calibrated to read in revolutions per minute (RPM). Two RPM ranges are provided on your Tune-Up Meter. Most tune-up work is done with the engine running at idle or low speed. The LOW RPM range is used for this work. You may have an occasion to test the engine speed under road conditions, or to calibrate a permanently installed tachometer. The HIGH RPM range is used for this work. CAUTION: Do not run the engine over 3000 RPM under a no-load condition.

RPM Measurement

1. Start the engine and allow it to come to normal operating temperature.
2. Set the FUNCTION switch to LOW RPM.
3. Set the CYLINDERS switch to correspond to the number of cylinders of the engine under test.

4. Connect the test leads to the ignition coil as shown in Figure 4. Be sure to observe the correct polarity. (The FUNCTION switch may be turned to any mode without disconnecting the test leads.) Read the appropriate RPM scale and multiply the reading by 100 to determine the engine speed.

NOTE: Some ignition coil wires have an insulator that completely covers the ignition coil terminals. Use the two #10 solder lugs provided as shown in the inset drawing of Figure 4. Remember to remove the solder lugs when you have finished making adjustments with the Tune-Up Meter.

The Importance of Proper Engine Speed

There are several electrical and mechanical systems in an automobile that rely on a certain engine speed in order to function properly. The generator or alternator output and the operation of the voltage regulator must be checked at engine speeds specified by the manufacturer. Idle speed is critical in automobiles with automatic transmissions. If the idle speed is too low, the engine may tend to stall when the car is stopped. If the idle speed is too high, the car may tend to creep more than normal. Engine governors and distributor advance mechanisms become operational at certain engine speeds. Consult the manufacturer's recommendations when making adjustments on these electrical and mechanical systems.

Carburetor Adjustment

In order to realize the best efficiency and smoothest operation at idle speed, the carburetor idle adjustment screws must be set properly. The best setting may be found by checking the RPM with the Tune-Up Meter as the carburetor adjustments are made.

Many carburetors have a fast-idle adjusting screw in addition to a slow-idle adjusting screw. In this type of carburetor, it is the fast-idle screw that rests against the fast-idle cam. The fast-idle cam is positioned by the automatic choke mechanism which responds to engine temperature. When the engine is at normal operating temperature and the choke is fully open, the fast-idle screw no longer touches the fast-idle cam. The throttle (and consequently, idle speed) is then adjusted with the slow-idle adjusting screw. Consult a service manual for the procedure and engine speeds specified for these adjustments. The following procedure is satisfactory for most engines for adjusting the idle-mixture adjusting screw.

Set the FUNCTION switch on LOW RPM and the CYLINDERS switch on the number of cylinders of the engine under test. Allow the engine to come to normal operating temperature. Set the slow-idle adjusting screw for RPM near the proper idling speed. Gradually turn in on the idle-mixture adjusting screw until the engine speed begins to decrease. Turn out on the screw until a maximum idle speed is reached. On multi-barreled carburetors with two idle-mixture adjusting screws, readjust each screw alternately as there may be some interaction between the two adjustments. When the idle-jet screws are properly adjusted, reset the slow-idle adjusting screw for the proper RPM. If considerable adjustment of the slow-idle screw is necessary, repeat the above procedure. Always adjust the idle-jet mixture first for maximum idlng speed and smoothest running, and finish the adjustment by setting the RPM with the slow-idle adjusting screw.

VOLTMETER

Before making voltage tests or measurements, it is helpful to check certain parts of the electrical system first.

1. Check the generator or alternator mountings to see that they are secure.

2. Check the fan belt for correct tension, and check the fan belt pulleys.

3. Make sure that all of the electrical connections are tight, and that the wires are in good condition.

4. Check battery cable connections at the battery terminals. Clean off all corrosion and tighten the clamps if necessary.

5. Check the electrolyte level in the battery and add distilled water if it is low.

6. Measure the specific gravity of the electrolyte, and charge the battery if the reading is low. If water has been added to the battery, charge the battery for about an hour to mix the water and electrolyte before making a specific gravity reading.

7. Warm up the engine and all parts of the charging system before making electrical tests.

Normal Battery Voltage

With no current drain (all switches off), a 12 volt battery should read between 12.2 and 12.8 volts, and a 6 volt battery should read between 6.1 and 6.4 volts. Voltages less than these indicate a worn or weak battery.

Battery Voltage When Starting

It is normal for the battery voltage to drop when it is under a heavy load, or current drain, for example, when the starter motor is cranking the engine. A good 12 volt battery voltage will drop to about 9.5 volts, and a 6 volt battery will drop to about 4.75 volts under a starting load. A voltage drop of more than these figures indicates either a worn battery, or one of insufficient capacity.

Charging Voltage

Run the engine at a fast idle (about 1500 RPM), turn off all lights and accessories, and measure the charging voltage at the battery. This should usually be between 13.2 and 15.2 volts for a 12 volt battery and between 6.6 and 7.6 volts for a 6 volt battery.

In most cars that have a 12 volt electrical system, a voltage dropping resistance is in series with the coil primary. This results in a primary voltage that is less than the battery voltage when the ignition switch is turned on. (This resistance is bypassed when the starting switch is turned to start the engine.)

Voltages lower than 6.6 in a 6 volt system or 13.2 in 12 volt systems, indicate either a faulty generator or alternator, or faulty or improperly adjusted voltage regulator, or a worn out battery. Higher than specified voltages (generally 7.6 in 6 volt systems and 15.2 in 12 volt systems) indicate either a faulty, or improperly adjusted voltage regulator, poor battery cable connections, or a defective battery. These values should be checked against the specifications for the electrical system under test.

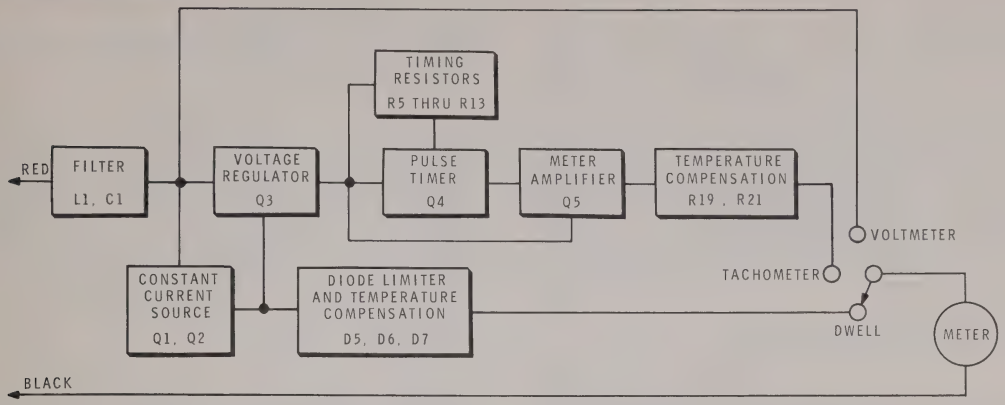
CIRCUIT DESCRIPTION

Refer to the Block Diagram on Page 21 and to the Schematic (fold-out from Page 27) while reading the Circuit Description.

The Tune-Up Meter does not contain an internal power supply, but obtains its power from the electrical system of the engine under test. The amount of power required to operate the Tune-Up Meter is so very small that it does not interfere with the normal operation of the engine.

TACH-DWELL INPUT CIRCUITRY

Both the Tachometer and Dwell Meter utilize the DC voltage pulses produced by the distributor for the input signal. The signal is applied through choke L1 and diode D1 to transistors Q1 and Q2. Choke L1 and capacitor C1 function as a filter to remove most of the inductive transients from the square wave input. Capacitor C2 provides additional filtering when the Tune-Up Meter is switched to the Dwell mode. Diodes D1 and D2 provide reverse current protection for transistors Q1 and Q2, in case the test leads are improperly connected. Transistors Q1 and Q2 function as a constant current source for reference diodes D3 and D4. Any input voltage between approximately 5 and 15 volts will produce a constant current and therefore a clamped voltage of 2.8 volts at the collector of transistor Q2.



BLOCK DIAGRAM

DWELL METER

Dwell Pulse Analysis

The closing and opening of the distributor points produces a square wave, as shown in Figure 5. If the closed and open times are equal, and the pulses are of a sufficiently high frequency, the meter will read an average current of approximately one-half the maximum current.

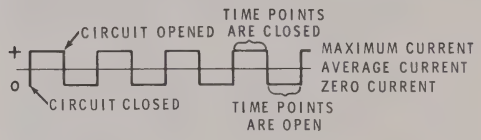


Figure 5

If the distributor points are set with a small dwell angle, that is, if the closed time is considerably less than the open time, the average current will be low, as shown in part A of Figure 6. The reverse is true for distributor points set with a large dwell angle. The average current and the meter reading will be high, as shown in part B of Figure 6.

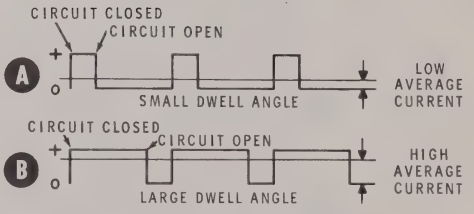


Figure 6

Figure 7 illustrates how dwell angle readings are independent of the engine speed. As shown in part A, a given engine speed will produce an average current, due to the open and closed times of the distributor points. Doubling the engine speed, as shown in part B, doubles both the open and closed times, leaving the average current unchanged.

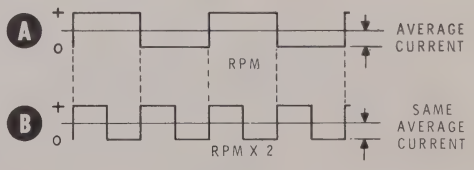


Figure 7

Dwell Circuit

In the Dwell mode, the dwell signal at the collector of Q2 is applied to diodes D5, D6, and D7. These diodes perform two functions: they clamp the dwell signal at a fixed level, and they provide temperature compensation for the dwell circuit. The dwell signal is then passed to dwell calibrating control R4 to the Function switch, and then to the meter.

TACHOMETER

Tachometer Pulse Analysis

As shown in part A of Figure 8, when the distributor points close and the pulse begins, transistor Q5 conducts and the meter begins to register the current. At the same time, capacitor C3 begins to charge with a voltage coupled through one of the timing resistors. Before the distributor points open to end the pulse, C3 becomes charged, Q4 conducts, and Q5 cuts off. This causes the meter to respond to only a small part of the whole pulse. The measured pulse duration is independent of engine speed, and is changed only by selecting a different timing resistor with the Function and Cylinders switches. The waveform at the meter circuit is illustrated by part B of Figure 8. The short "on" pulse and long "off" periods cause the meter to indicate a low average current.

Parts C and D of Figure 8 illustrate the effect of doubling the engine speed as given in parts A and B. The "on" pulse is of the same duration, but there are twice as many in a given time period, which causes the meter to indicate a higher average current. The meter has been calibrated to read out in actual RPM.

Tachometer Circuit

Voltage from the collector of Q2 (as described in the "TACH-DWELL INPUT CIRCUITRY" paragraph on Page 20) is applied to the base of pass transistor Q3, at the same time that the pulse is applied to the collector of Q3. Since the base bias voltage is constant, Q3 acts as a variable resistance and keeps the emitter voltage constant even when the emitter load changes. The signal from the emitter of Q3 is coupled to the meter through Tachometer Calibrating control R17 and the temperature compensating network consisting of R19 and R21. When the Function switch is in either tachometer range, the signal from the meter is passed

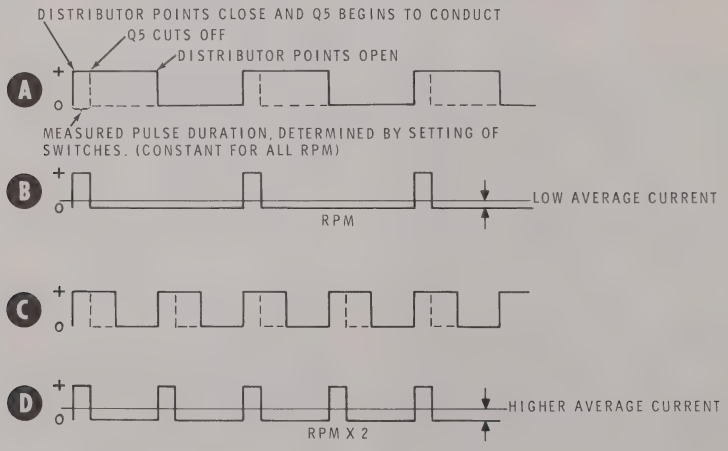


Figure 8

to the common negative return, through diode D9 and transistor Q5. Transistor Q5 began to conduct as soon as the distributor pulse started. It is turned off, at a predetermined time, by pulse timing transistor Q4, in the following manner. The constant voltage at the emitter of Q3 charges capacitor C3 through one of the selected timing resistors. When C3, at the base of Q4, charges to approximately .6 volt, transistor Q4 begins to conduct. When Q4 conducts, the voltage at the base of Q5 drops and biases Q5 off, which shuts off the current through the meter. This chain of events takes place before the distributor points open.

When the distributor points open, an induced voltage is produced in the primary and the secondary of the ignition coil. The high potential secondary voltage is used to fire the spark plug; the primary voltage appears as a potential across the two test leads. This potential is opposite in polarity to the battery voltage, that is, the potential at point B on the circuit board is now positive, and point A is negative. This voltage, in looking for a completed circuit, passes through choke L1, transistor Q3 (which acts like a zener diode under this condition), the Function switch, the Cylinders switch and one of the timing resistors, to one side of capacitor C3. Diode D8 completes this circuit and also provides a consistent starting potential across C3 for the next pulse. This constant starting point provides accurately timed pulses for the tachometer.

The current pulses seen by the meter are always at a constant amplitude. Different meter readings are determined by the duration and frequency of these pulses. The inertia of the meter movement and the damping effect of capacitor C4 averages the pulses to a steady meter reading.

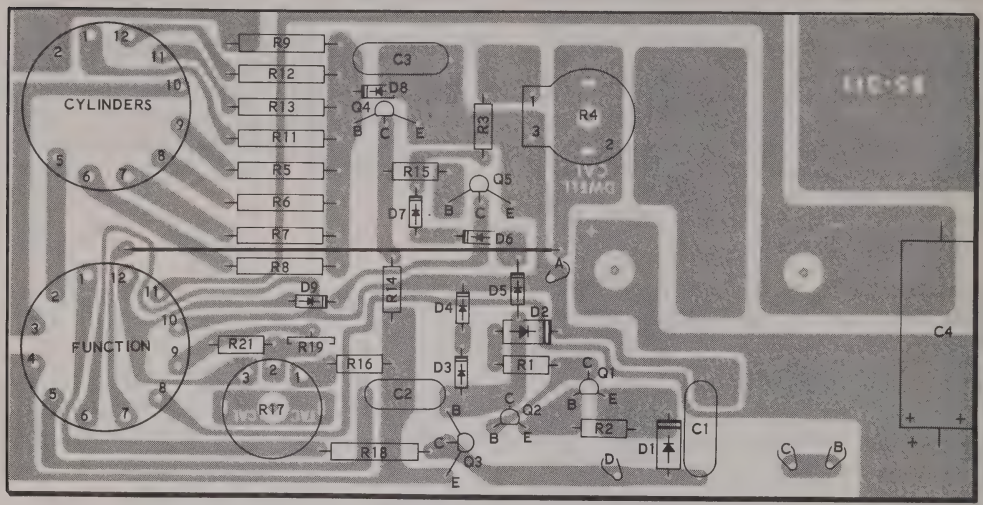
VOLTMETER

With the Function switch in the DC VOLTS position, the meter is coupled directly to the test leads through calibrating resistor R18 and choke L1.

The Voltmeter was designed for use in automotive electrical measurements only, and therefore, should not be used to measure voltages in high impedance electronic circuits. No damage will result to the voltmeter, but its low impedance may load a high impedance circuit, causing it to give erroneous readings.

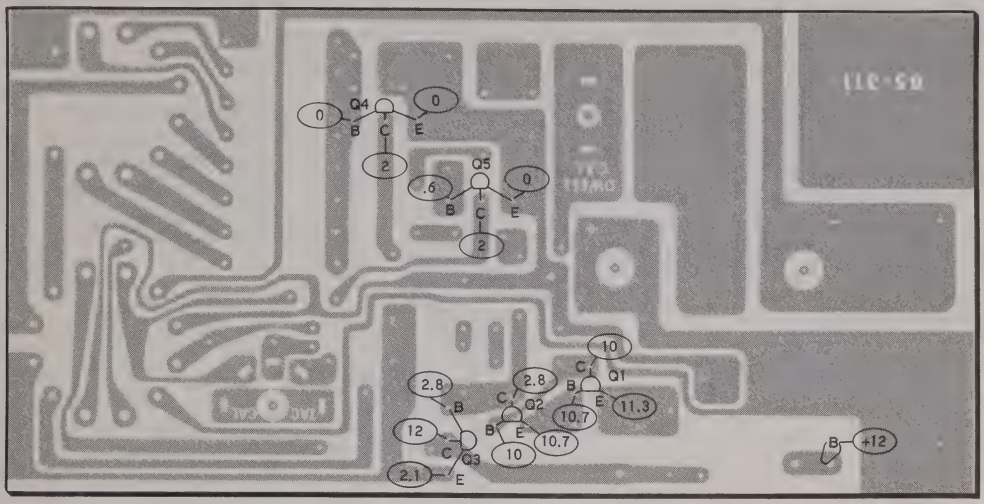
CIRCUIT BOARD X-RAY VIEW

(VIEWED FROM FOIL SIDE)



VOLTAGE CHART

(VIEWED FROM FOIL SIDE)



NOTES:

1. ⬭ THIS SYMBOL INDICATES DC VOLTAGES MEASURED UNDER THE FOLLOWING CONDITIONS:
   CYLINDERS SWITCH SET AT 8
   FUNCTION SWITCH SET AT DWELL
   12 VOLTS DC INPUT ON TEST LEADS

2. ALL VOLTAGES ARE MEASURED WITH A HIGH IMPEDANCE VOLTMETER FROM COMMON (-) TO THE POINT INDICATED.

REPLACEMENT PARTS PRICE LIST

To order parts, use the Parts Order Form furnished with this kit. If Parts Order Form is not available, refer to Replacement Parts in the Kit Builders Guide.

The following prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from an authorized Service Center or Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties and rates of exchange.

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/2 Watt		
1-3	.10	100 Ω
1-112	.10	180 Ω
1-9	.10	1000 Ω
1-10	.10	1200 Ω
1-20	.10	10 kΩ
1-22	.10	22 kΩ
1 Watt		
1-9-1	.10	10 kΩ
Precision, 1%		
2-263	.20	6600 Ω
2-264	.20	8500 Ω
2-265	.20	12.2 kΩ
2-266	.20	15 kΩ
2-267	.20	16 kΩ
2-189	.20	18 kΩ
2-268	.20	24 kΩ
2-120	.25	36 kΩ
2-269	.20	48 kΩ
Other Resistors		
9-28	.75	100 Ω thermistor
11-87	.65	1000 Ω (1k) control
10-200	.50	2000 Ω (2k) control
CAPACITORS		
25-199	.60	500 μF electrolytic
27-34	.25	.2 μF Mylar
27-50	.40	.39 μF Mylar
27-61	.40	.47 μF Mylar

PART No.	PRICE Each	DESCRIPTION
DIODES-TRANSISTORS		
56-26	.25	1N191 crystal diode
56-56	.20	1N4149 silicon diode
56-61	.55	Reference diode (stabistor)
57-27	.50	1N2071 silicon diode
417-118	.40	2N3393 transistor
417-201	.50	29A829 transistor
SWITCHES		
63-552	1.95	10-terminal rotary
63-553	2.20	12-terminal rotary
HARDWARE		
250-89	.05	6-32 x 3/8" screw
254-1	.05	#6 lockwasher
252-3	.05	6-32 nut
253-10	.05	Switch flat washer
252-7	.05	Switch nut
259-5	.05	#10 solder lug
PLASTIC PARTS		
73-20	.10	Red alligator clip insulator
73-21	.10	Black alligator clip insulator
73-34	.10	Red insulator
75-30	.10	Test cable strain relief
95-29	1.60	Instrument case
490-5	.10	Nut starter
WIRE		
89-4	.60	2-conductor cable
89-20	.45	Calibration cable, with plug
344-59	.05/ft	Hookup wire
MISCELLANEOUS		
46-49	2.35	Choke
85-311-1	2.30	Circuit board
203-615	.90	Chassis
260-1	.10	Alligator clip
407-143	9.20	Meter
455-50	.10	Knob bushing
462-245	.25	Knob
390-262	.25	Model number label
390-285	.10	Connections label
331-6	.15	Solder
	2.00	Manual (See front cover for part number.)

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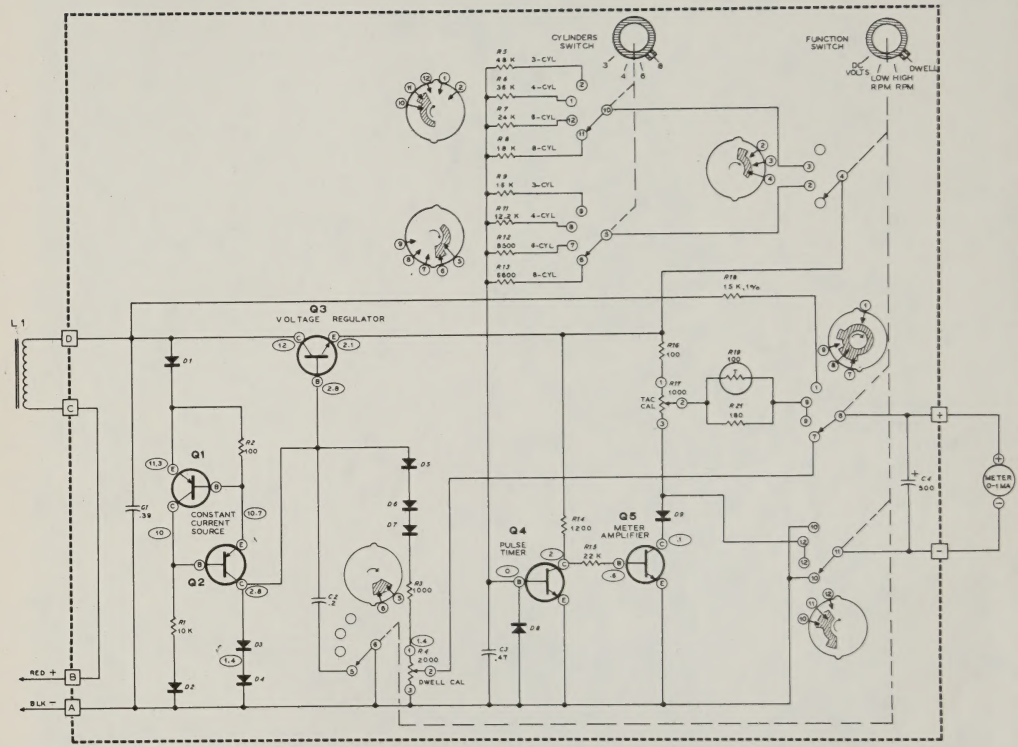
462-245	.25	Knob
390-262	.25	Model number label
390-285	.10	Connections label
331-6	.15	Solder
	2.00	Manual (See front cover for part number.)

NOTES:

1. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K = 1000 OHMS).
2. TIMING RESISTORS, R5 THROUGH R13, ARE ± 1%
3. ALL CAPACITOR VALUES ARE IN µF.
4. SWITCHES ARE SHOWN IN FULL COUNTERCLOCKWISE POSITION AS VIEWED FROM THE KNOB END.
5. REFER TO THE CIRCUIT BOARD X-RAY VIEW FOR THE LOCATION OF PARTS.
6. ☐ THIS SYMBOL INDICATES CONNECTION TO CIRCUIT BOARD.
7. ⬭ THIS SYMBOL INDICATES DC VOLTAGES MEASURED UNDER THE FOLLOWING CONDITIONS:
   CYLINDERS SWITCH SET AT 8
   FUNCTION SWITCH SET AT DWELL
   12 VOLTS DC INPUT ON TEST LEADS
8. ALL VOLTAGES ARE MEASURED WITH A HIGH IMPEDANCE VOLTMETER FROM COMMON (-) TO THE POINT INDICATED.



SCHEMATIC OF THE
HEATHKIT®
AUTOMOTIVE TUNE-UP METER
MODEL ID-29

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) If you wish, you can deliver your kit to a nearby Heath Authorized Service Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heath Authorized Service Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heath Authorized Service Center, please ship it to the factory at Benton Harbor, Michigan and follow the following shipping instructions:

Prepare a letter in duplicate, containing the following information:

- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan.

Check the equipment to see that all parts and screws are in place. (Do not include wooden cabinets when shipping receivers, tuners, amplifiers, or TV sets, as these are easily damaged in shipment.) Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

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Benton Harbor, Michigan 49022

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